



Updated Phase 6 Modeling Results for Climate Change Impacts

WQGIT Presentation to the Principals Staff Committee
October 8, 2020

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Previous PSC 2025 Climate Change Decisions

1. Incorporate Climate Change in the Phase III WIPs

Include a narrative strategy in the Phase III WIPs that describe the jurisdictions current action plans and strategies to address climate change, as well as the jurisdiction-specific nutrient and sediment pollution loadings due to 2025 climate change conditions, while incorporating local priorities and actions to address climate change impacts.

2. Understand the Science

Address the uncertainty by documenting the current understanding of the science and identifying research gaps and needs:

- a) Develop an estimate of pollutant load changes (N, P and Sediment) due to climate change conditions.
- b) Develop a better understanding of the BMP responses, including new or other emerging BMPs, to climate change conditions.
- c) In 2021, the Partnership will consider results of updated methods, techniques, and studies and revisit existing estimated loads due to climate change to determine if any updates to those load estimates are needed.
- d) Jurisdictions will be expected to account for additional nutrient and sediment pollutant loads due to 2025 climate change conditions in a Phase III WIP addendum and/or 2-year milestones beginning in 2022.

3. Incorporate into Milestones

Starting with the 2022-2023 milestones, determine how climate change will impact the BMPs included in the WIPs and address these vulnerabilities in the two-year milestones.



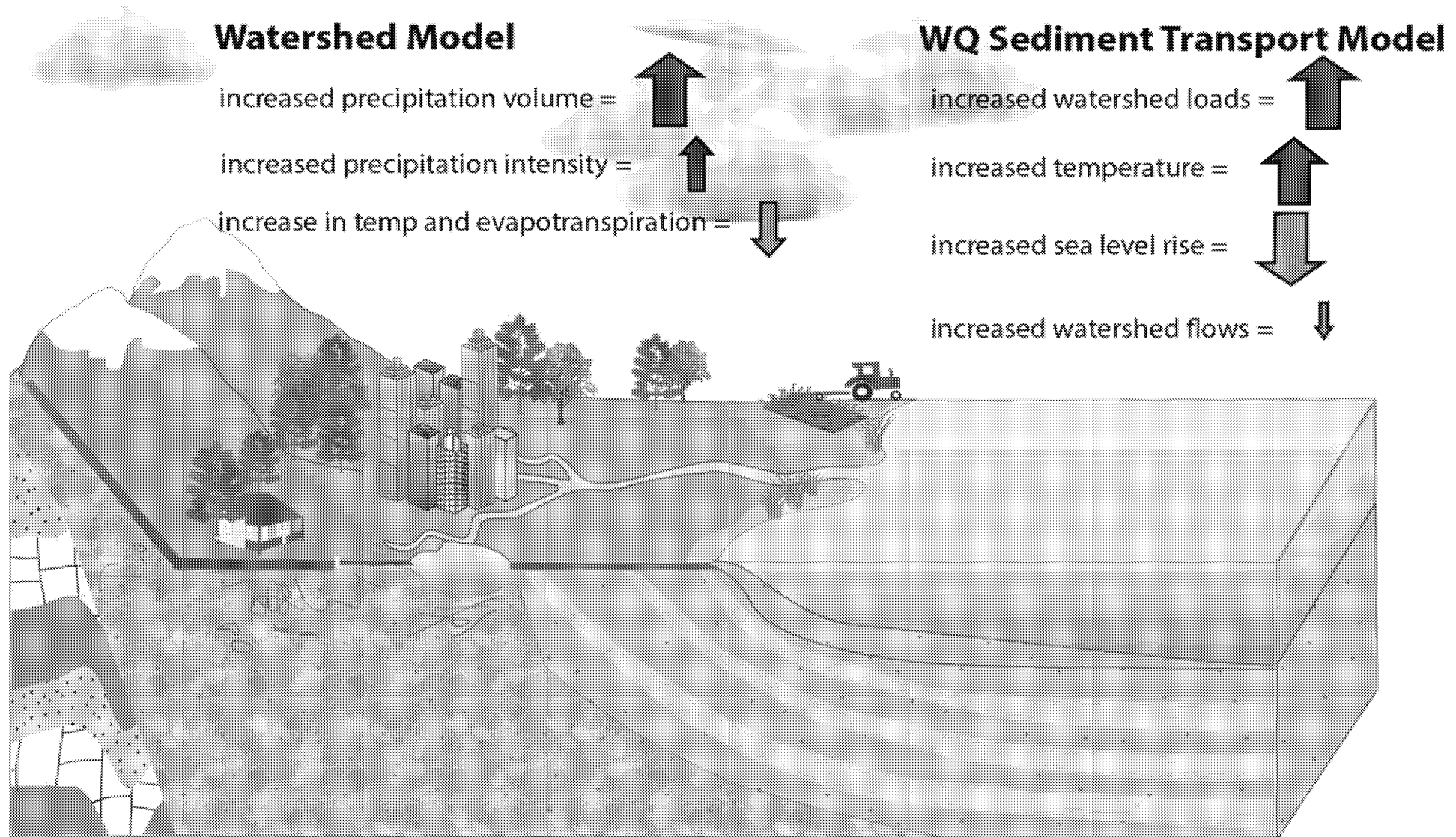
2017/2018 Climate Change Loads and Planning Targets

Chesapeake Bay Program
Science, Restoration, Partnership

Jurisdiction	Nitrogen Climate Change	Nitrogen Planning Target	Phosphorus Climate Change	Phosphorus Planning Target
NY	0.400 (3.8%)	11.59	0.014 (2.9%)	0.606
PA	4.135 (5.7%)	73.18	0.141 (4.7%)	3.073
MD	2.194 (4.8%)	45.30	0.114 (3.2%)	3.604
WV	0.236 (3.7%)	8.35	0.019 (3.9%)	0.456
DC	0.006 (0.3%)	2.43	0.001 (0.8%)	0.130
DE	0.397 (8.5%)	4.59	0.006 (5.1%)	0.120
VA	1.722 (3.1%)	55.82	0.193 (3.0%)	6.186
Basinwide	9.09 (4.6%)	201.25	0.489 (3.4%)	14.173

*Units: millions of pounds

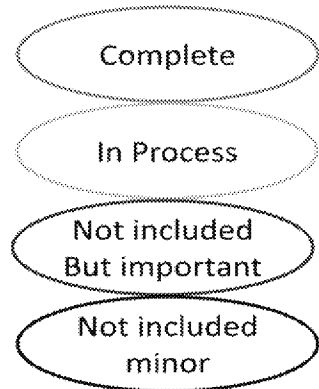
Components of Climate Change – Effect on Tidal Dissolved Oxygen





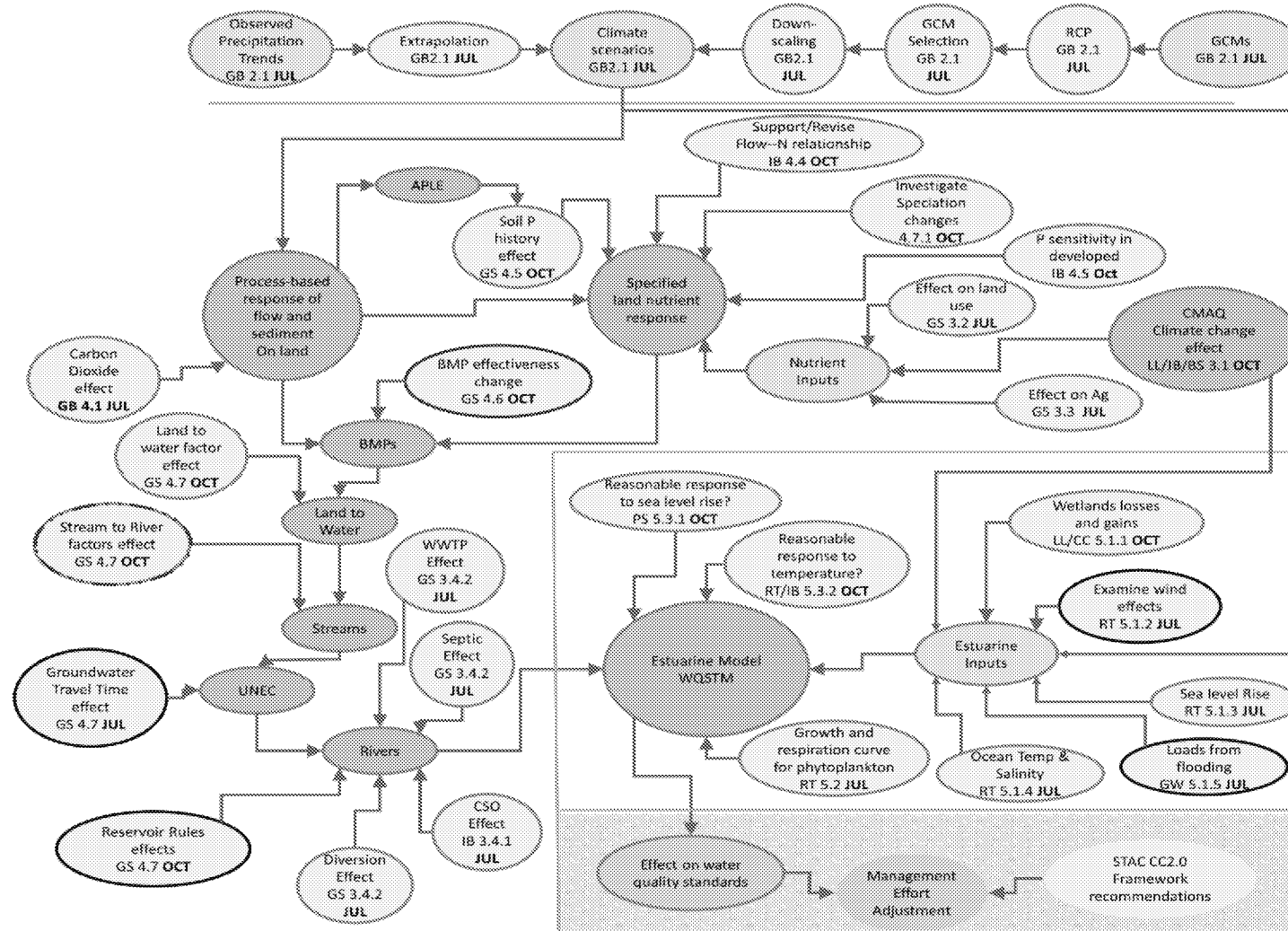
Elements of Chesapeake Water Quality Climate Risk Assessment

Model
Data Set
Endpoint
Project/Decision



Initials indicate the responsible person
Numbers indicate the section of the documentation

Climate Change Processes and Dependencies



Climate

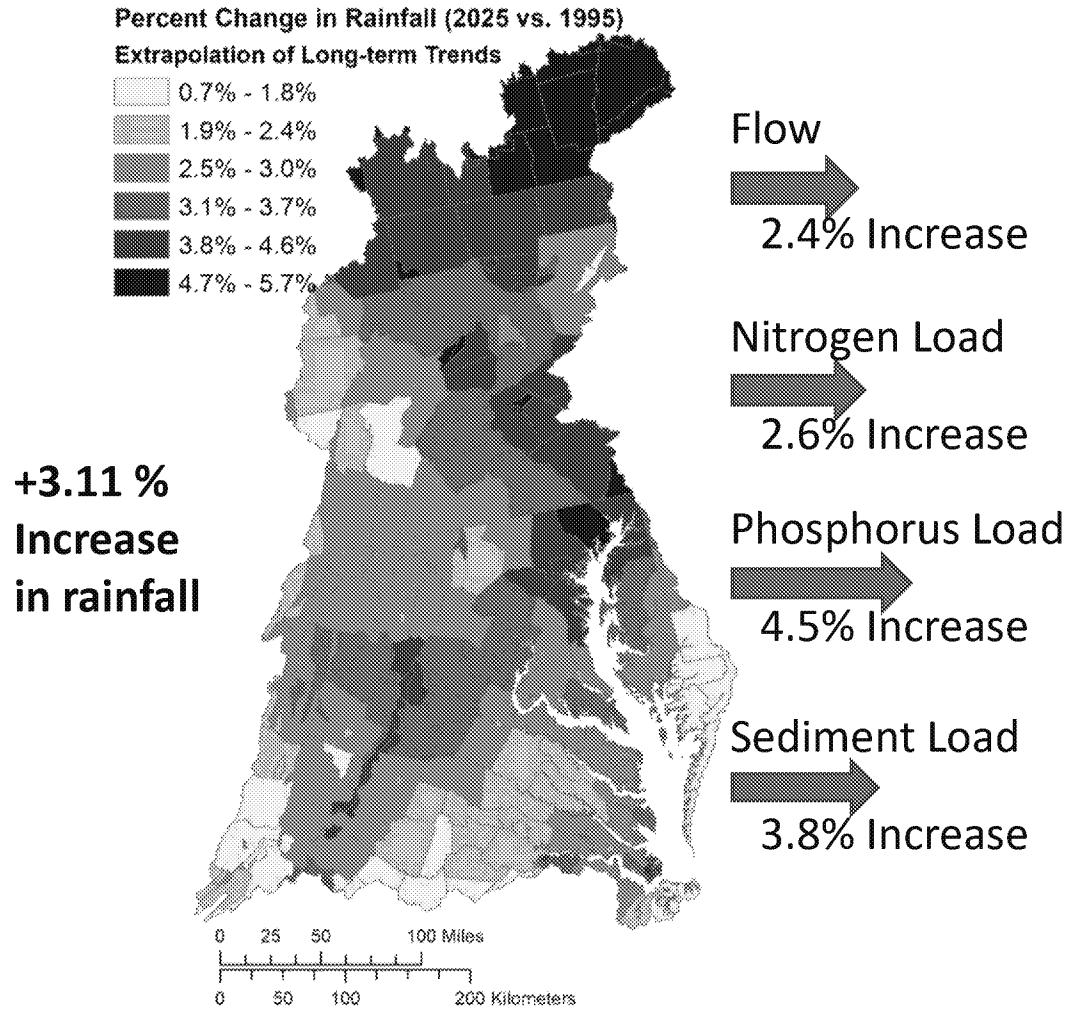
Watershed

Estuary

Management

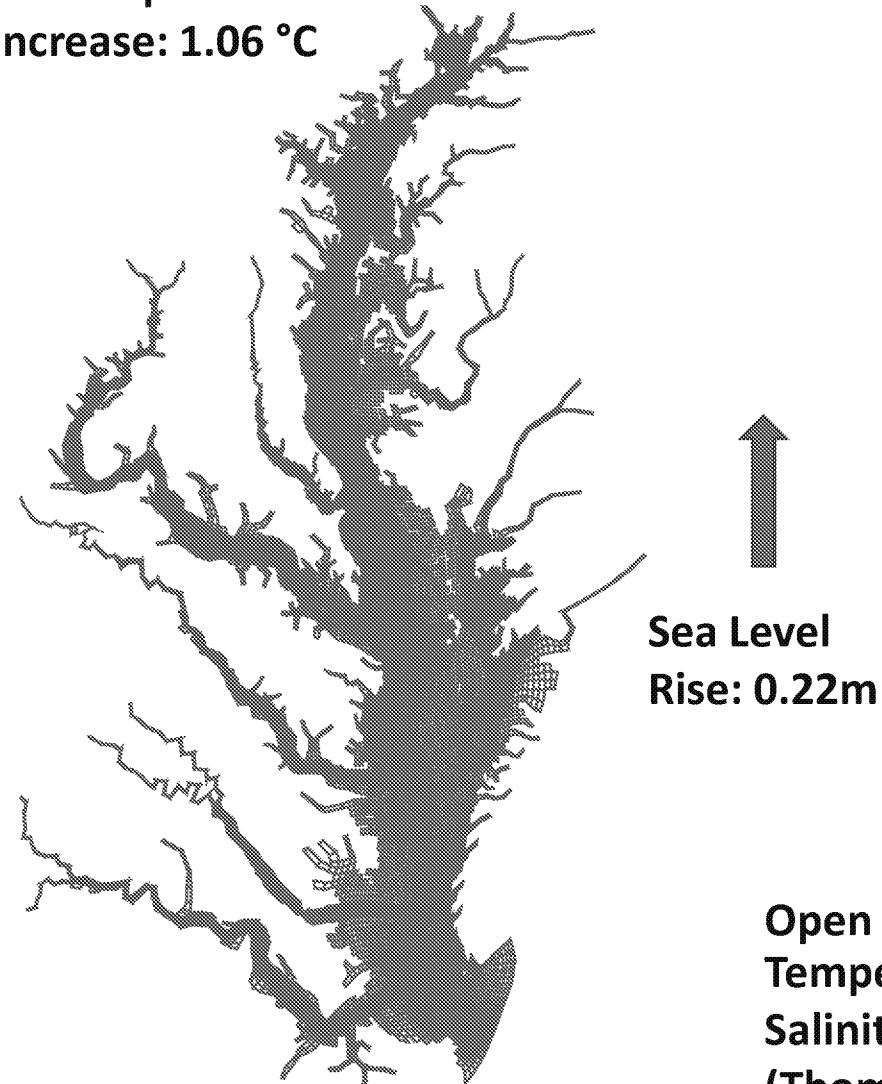


Elements of 2025 Climate Change (1995-2025)



Phase 6 Watershed Model

Air-temperature increase: 1.06 °C



Model: CH3D-ICM 400m-1km Resolution

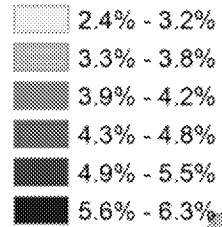


Elements of 2035 Climate Change (1995-2035)

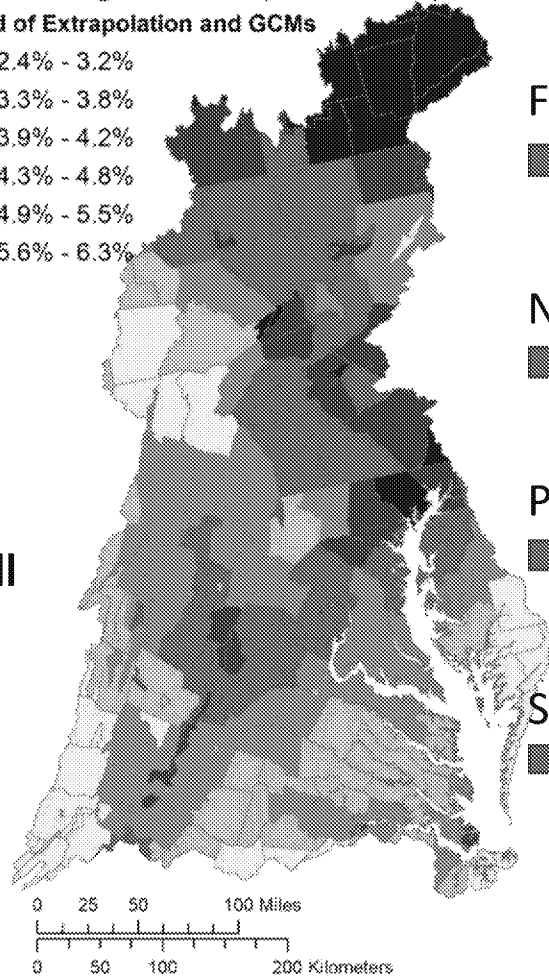
Air-temperature
increase: 1.39 °C

Percent Change in Rainfall (2035 vs. 1995)

Hybrid of Extrapolation and GCMs



+4.21 %
Increase
in rainfall



Phase 6 Watershed Model

Flow

→
3.7% Increase

Nitrogen Load

→
4.7% Increase

Phosphorus Load

→
9.9% Increase

Sediment Load

→
8.5% Increase



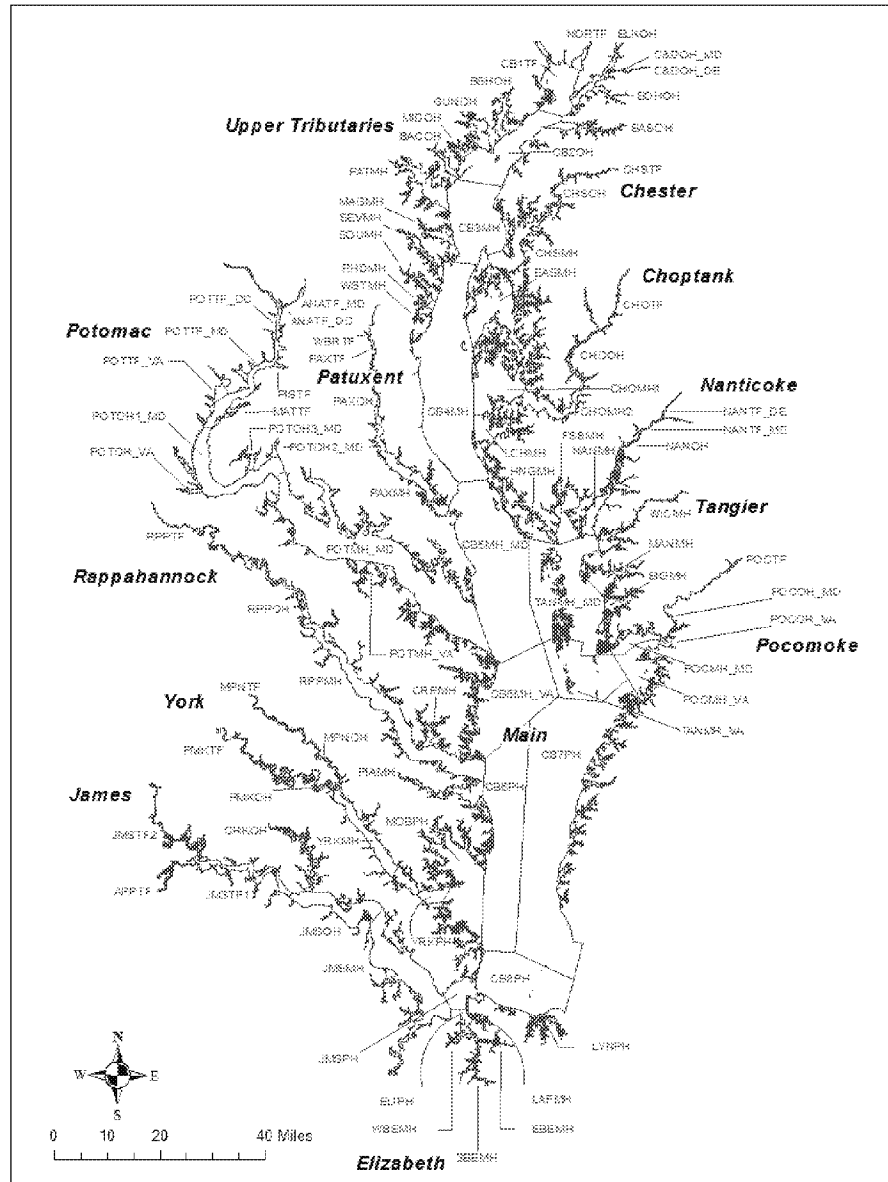
Model: CH3D-ICM 400m-
1km Resolution

↑
Sea Level
Rise: 0.31m

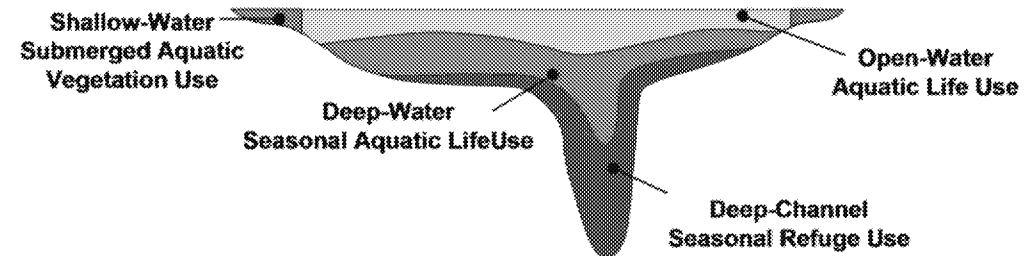
Open boundary:
Temperature: +1.32 °C;
Salinity: +0.25 psu
(Thomas et al., 2017)



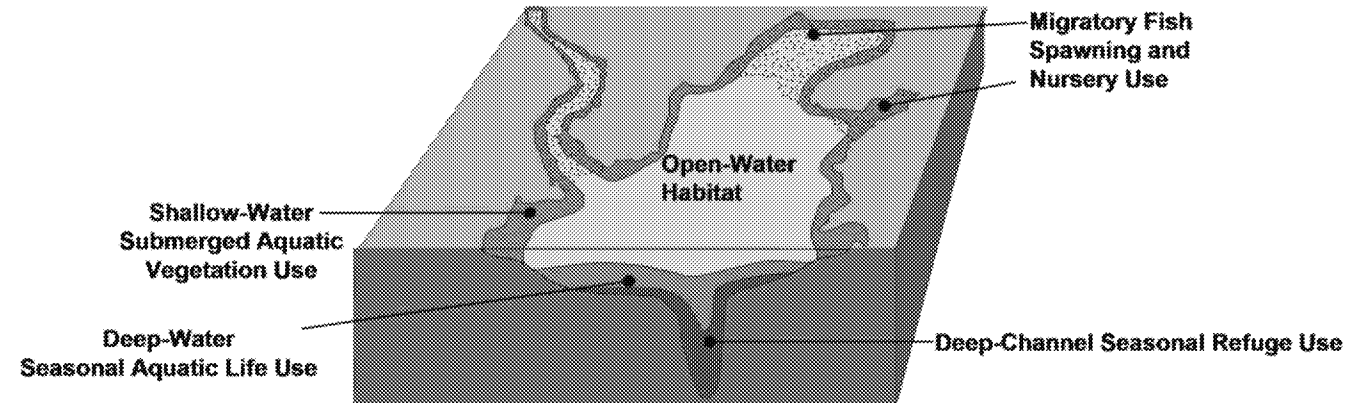
Overview of Bay Designated Uses



A. Cross Section of Chesapeake Bay or Tidal Tributary



B. Oblique View of the "Chesapeake Bay" and its Tidal Tributaries





ΔAchievement of Deep Channel DO Water Quality Standard

Achievement of **Deep Channel DO** water quality standard (1mg/l instantaneous minimum) expressed as ***an incremental increase*** over the PSC agreed to 2025 planning targets

CB Segment	State	2025 Climate 2025 Land Use	2035 Climate 2025 Land Use	2045 Climate 2025 Land Use	2055 Climate 2025 Land Use
		204TN 14.0TP 1993-1995 DO Deep Channel	208TN 14.6TP 1993-1995 DO Deep Channel	212TN 15.4TP 1993-1995 DO Deep Channel	220TN 16.7TP 1993-1995 DO Deep Channel
CB3MH	MD	0.00%	0.00%	0.00%	0.00%
CB4MH	MD	1.47%	3.15%	4.62%	7.31%
CB5MH	MD	0.00%	0.00%	0.00%	0.00%
CB5MH	VA	0.00%	0.00%	0.00%	0.00%
POTMH	MD	0.00%	0.00%	0.00%	0.00%
RPPMH	VA	0.00%	0.00%	0.00%	0.00%
ELIPH	VA	0.00%	0.00%	0.00%	0.00%
CHSMH	MD	0.01%	0.92%	1.08%	2.34%





ΔAchievement of Deep Water DO Water Quality Standard

Achievement of **Deep Water DO** water quality standard (3 mg/l 30-day mean) expressed as ***an incremental increase*** over the PSC agreed to 2025 planning targets.

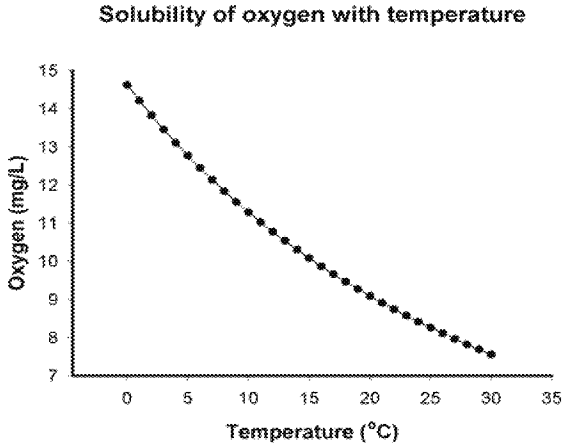
		2025 Climate 2025 Land Use 204TN, 14.0TP 1993-1995 DO Deep	2035 Climate 2025 Land Use 208TN, 14.6TP 1993-1995 DO Deep	2045 Climate 2025 Land Use 212TN, 15.4TP 1993-1995 DO Deep	2055 Climate 2025 Land Use 220TN, 16.7TP 1993-1995 DO Deep
CB Segment	State	Water	Water	Water	Water
CB3MH	MD	0.01%	0.15%	0.16%	0.21%
CB4MH	MD	0.94%	1.61%	2.00%	2.66%
CB5MH	MD	0.52%	1.01%	1.32%	1.66%
CB5MH	VA	0.00%	0.00%	0.00%	0.00%
CB6PH	VA	0.00%	0.00%	0.00%	0.00%
CB7PH	VA	0.00%	0.00%	0.00%	0.00%
PATMH	MD	0.01%	0.02%	0.42%	2.66%
MAGMH	MD	1.66%	1.66%	1.91%	1.91%
SOUMH	MD	0.00%	0.00%	0.00%	0.00%
SEVMH	MD	0.00%	0.00%	0.00%	0.00%
PAXMH	MD	0.00%	0.00%	0.00%	0.00%
POTMH	MD	0.03%	0.15%	0.56%	0.81%
RPPMH	VA	0.00%	0.24%	1.48%	1.85%
YRKPH	VA	0.00%	0.00%	0.00%	0.00%
ELIPH	VA	0.00%	0.00%	0.00%	0.00%
SBEMH	VA	0.00%	0.00%	0.44%	3.12%
CHSMH	MD	0.00%	0.00%	0.00%	0.00%



Tidal Fresh Open Water DO Water Quality Standard Violation Rates

Nonattainment of **Tidal Fresh Open Water DO** water quality standard (5.5mg/l 30-day mean)

Estimating substantial increases in Open Water DO non-attainment under increased (1°C) 2025 temperature in shallow waters.



		1995 Climate	2025 Climate	2035 Climate	2045 Climate	2055 Climate
PAXTF	MD	2.81%	11.93%	11.95%	12.37%	13.35%
WBRTF	MD	0.00%	32.27%	32.27%	39.65%	54.64%
PISTF	MD	4.63%	4.65%	4.65%	4.65%	4.65%
MATTF	MD	0.00%	0.00%	0.00%	0.00%	0.00%
RPPTF	VA	0.00%	0.00%	0.00%	0.00%	1.65%
MPNTF	VA	1.31%	27.03%	36.88%	41.21%	35.67%
PMKTF	VA	6.90%	71.26%	81.54%	74.44%	69.83%
JMSTFL	VA	0.00%	0.00%	0.38%	0.96%	1.02%
JMSTFU	VA	0.00%	0.00%	0.00%	0.00%	0.00%
APPTF	VA	4.59%	0.00%	0.00%	0.00%	4.59%
NORTF	MD	0.00%	0.00%	0.00%	0.00%	0.00%
CHSTF	MD	0.00%	0.00%	0.00%	0.00%	0.00%
CHOTF	MD	0.00%	0.00%	0.00%	0.00%	0.00%
NANTF_ML	MD	0.00%	0.73%	4.70%	0.73%	0.00%
POCTF	MD	0.00%	69.83%	77.48%	77.48%	77.48%



Open Water is Important!

- The Open Water criteria are based on living resource needs for striped bass and other important species.
- There is a huge amount of Open Water (2/3 of the Bay) with DO water quality standards in place to protect living resources.
- It is the portion of the Bay that we interact with the most.
- Shallow Open Water (less than 2 meters deep) may have increased impacts from future estimated temperature increases.
- Open Water DO nonattainment in shallow water requires additional investigation. Ultimately, an improved Bay Model simulation of shallow water is needed to better understand the climate effects on Open Water DO water quality standards in Chesapeake's shallow waters.



Main Bay and Tributary Open Water Violation Rates

Non-attainment of Open Water DO water quality standard (5 - 5.5 mg/l 30-day mean)

- Most areas do not reach violation, even by 2055
- CB6 and CB7 are much more effected

Planning						Planning					
Cbseg	Target	2025	2035	2045	2055	Cbseg	Target	2025	2035	2045	2055
CB1TF	0.00%	0.00%	0.00%	0.00%	0.00%	PAXMH	0.00%	0.00%	0.00%	0.00%	0.03%
CB2OH	0.00%	0.00%	0.00%	0.00%	0.00%	POTMH_MD	0.00%	0.00%	0.00%	0.00%	0.00%
CB3MH	0.00%	0.00%	0.00%	0.00%	0.00%	RPPMH	0.00%	0.00%	0.00%	0.00%	0.00%
CB4MH	0.00%	0.00%	0.00%	0.00%	0.00%	YRKPH	0.00%	0.00%	0.00%	0.00%	0.00%
CB5MH_MD	0.00%	0.00%	0.00%	0.00%	0.00%	MOBPH	0.00%	0.00%	0.01%	0.11%	0.16%
CB5MH_VA	0.00%	0.00%	0.00%	0.00%	0.00%	JMSPH	0.00%	0.00%	0.00%	0.00%	0.00%
CB6PH	0.03%	0.39%	0.71%	0.99%	1.29%						
CB7PH	0.32%	1.41%	2.11%	3.02%	4.19%	CHSMH	0.00%	0.00%	0.00%	0.00%	0.00%
CB8PH	0.00%	0.00%	0.00%	0.00%	0.00%	EASMH	0.00%	0.00%	0.00%	0.00%	0.00%
						CHOMH2	0.00%	0.00%	0.00%	0.00%	0.00%
						TANMH_MD	0.00%	0.00%	0.00%	0.00%	0.00%
						TANMH_VA	0.00%	0.00%	0.00%	0.00%	0.03%



Why are CB6 and CB7 acting so differently?

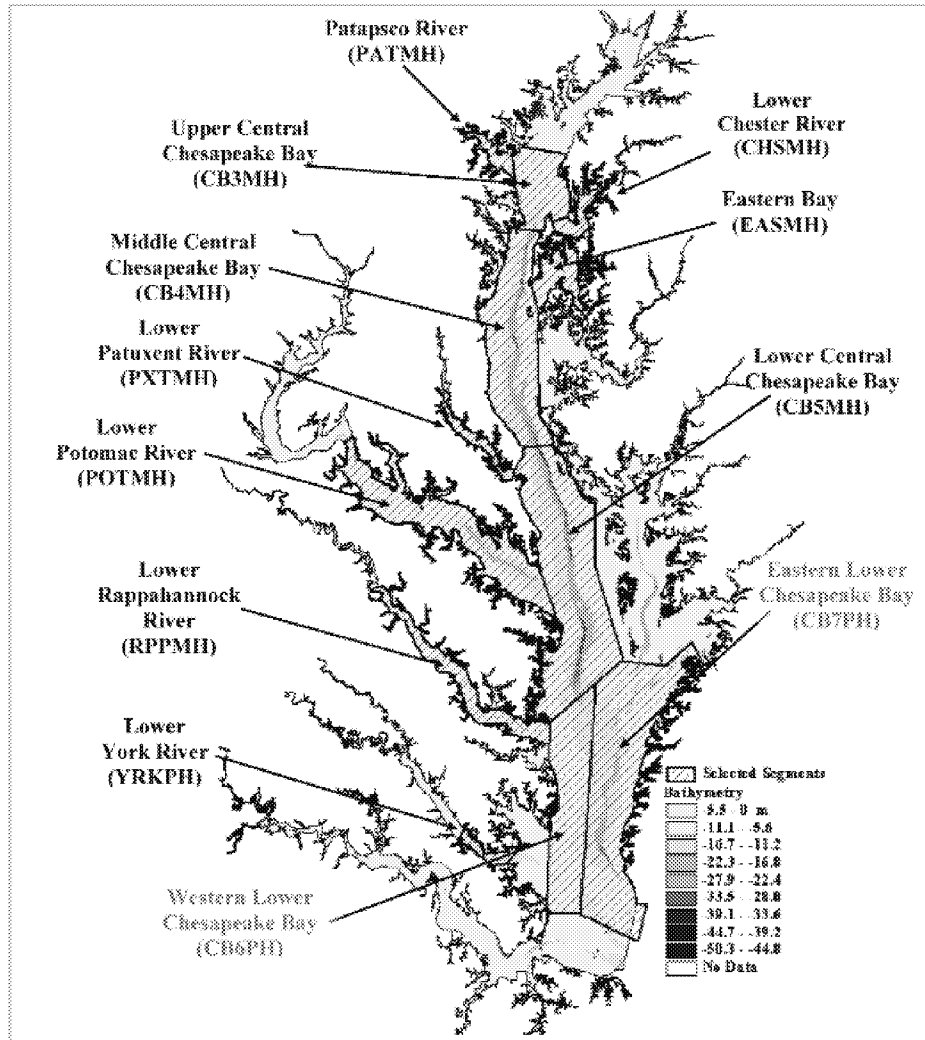


Figure IV-19. Chesapeake Bay Program segments identified as having chronic low dissolved oxygen.

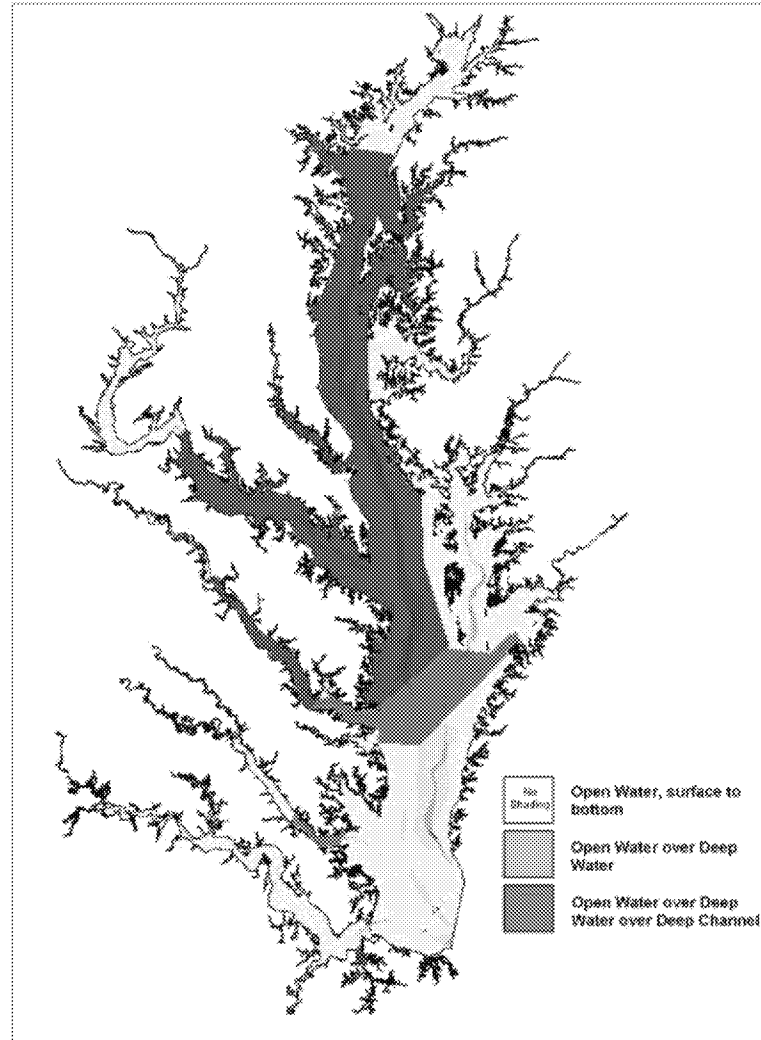


Figure IV-23. Map showing the dissolved oxygen designated uses of the Chesapeake Bay and its tidal tributaries.

- 2003 Technical Support Document

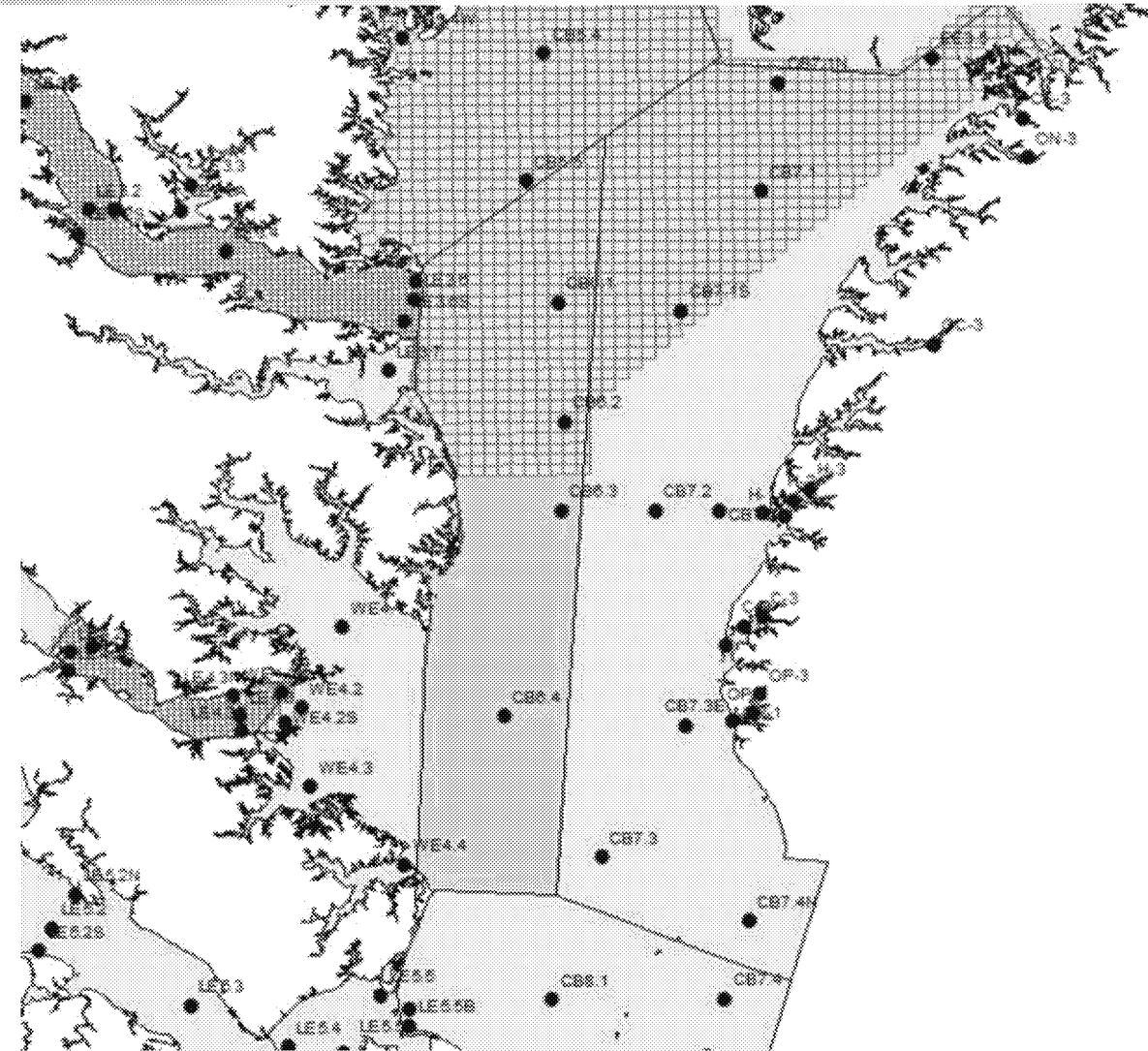
“The delineation of the boundary was determined by examining maps of contemporary dissolved oxygen concentration distributions and the anecdotal historical dissolved oxygen concentration data record.”



Deep Water Boundary

Chesapeake Bay Program
Science, Restoration, Partnership

- CB6 boundary adjusted in 2004 as:
 - Near the end of the natural channel
 - The point where non-attainment goes under 1% in the 2003 Cap Load allocations
- Modeling Team took a closer look at the Open Water DO nonattainment forecasted in CB6 and CB7
 - Nonattainment was happening below the pycnocline.
 - But DO concentrations below the pycnocline would not violate the Deep Water DO standard (> 3 mg/l).
- The Modeling Workgroup recommended to the WQGIT that it avoid driving allocations with CB6 and CB7 Open Water DO because:
 - Attainment is relatively insensitive to load reductions.
 - No other mainstem segment had Open Water DO violations estimated through 2055.
 - A more appropriate delineation of the designated uses of Open Water DO and Deep Water DO is needed.



Key Points in Assessment of 2025 Climate Change

- The efforts since December 2017 to understand the science have produced an improved model with a better understanding of the underlying processes
 - Revised load estimates will be focused on the deep water and deep channel designated uses
 - Improved model provides ability to consider alternative allocation methods
 - Adjustments to the designated uses in CB6 and CB7 are being considered
 - More work is needed on the shallow water simulation and understanding climate effects on BMPs
- Resulting Climate Change load estimates for 2025 have **decreased by about half** from the December 2017/March 2018 estimates (about 5M lbs TN)
- However, the estimated load reduction to address climate risk for 2035 is about twice that of the estimated 2025 nitrogen load reduction (about 10M lbs TN).
- The WQGIT is finalizing its specific recommendations to the Management Board for their consideration. Anticipate those moving forward to PSC at your next meeting (or two).